

A GPS-based examination of the mobility and exposure to risk of older drivers from rural and urban areas

By JP Thompson^{1,2}, MRJ Baldock¹, JL Mathias², LN Wundersitz¹

¹Centre for Automotive Safety Research, The University of Adelaide, South Australia

²School of Psychology, The University of Adelaide, South Australia

Abstract

This study examines whether older rural drivers are restricted in their driving mobility and are exposed to more risk when driving than older urban drivers. Participants (aged ≥ 75 years) from rural ($n = 28$) and urban ($n = 28$) areas of South Australia were monitored using GPS devices and telephone-based travel diaries. The rural and urban participants did not differ in the number of trips that they made for discretionary or non-discretionary activities. However, while rural participants were exposed to fewer intersections (potential conflict points) in their driving than urban older drivers, they drove further and for longer periods on roads with speed limits of 100 km/h or higher, and at GPS-measured speeds of 100 km/h or faster. Therefore, they are not less mobile but have a higher exposure to road conditions that are more likely to lead to serious and fatal injuries in a crash.

Keywords

Driving mobility, GPS, Older drivers, Road safety, Rural areas, Urban areas

Introduction

Driving enables older adults to remain mobile, which is important for their independence and lifestyle [1-3]. A loss of mobility through driving cessation can lead to depression [4, 5], a reduced network of friends [6], and an increased risk of mortality over a three-year period [7]. While mobility is desirable, it has also been found that older drivers have a higher crash rate per distance driven and an increased risk of being seriously or fatally injured [8-12]. It is thought that this increased risk of injury results from greater frailty, such that older people have a lower tolerance to physical trauma than younger persons [13, 14]. Consequently, the focus of recent research has been on maintaining an optimal level of mobility for older drivers, while also reducing their exposure to risk when on the road [15-17].

Older drivers who live in rural or remote areas are of particular interest because the nature of their driving environments may both restrict their mobility and increase their risk on the road. Firstly, in terms of mobility, the longer distances that need to be driven in these areas may

reduce the ease with which drivers are able to reach their destinations, which may make them reluctant to make any more trips than are absolutely necessary. Hough, Cao and Handy [18] examined the travel patterns of elderly women in rural areas of North Dakota, USA, and found they tended to make fewer trips than older women living in small urban areas. However, there may be more to a person's mobility than just the number of outings they undertake. Nordbakke [19] defines mobility as "the ability to choose where and when to travel and which activities to participate in outside the home in everyday life" (p.166). Mobility may be restricted for rural residents because they may have to prioritise their driving and neglect discretionary activities (e.g., social activities). Consistent with this, Hough et al. [18] found that rural older women travel less often than older women from small urban areas particularly for certain activities, such as going to a restaurant, friend's house, store, hair salon, or place to exercise. Thus, older rural drivers may do more driving because of the distances they need to travel, but their mobility may be restricted, which may affect their quality of life.

In terms of risk, the high crash rate per distance driven of older drivers may result from the fact that they travel smaller distances, on average, than younger drivers [8, 11, 13] and may therefore undertake most of their driving on local roads with more potential crash points (e.g., intersections) [20-22]. In contrast, drivers who travel large distances may do much of their driving on high-speed freeways, where there are fewer potential conflict points and crashes are rare per unit-distance [20-22]. An increased crash rate per distance driven has been shown to be the case for drivers who travel fewer kilometres, regardless of their age, and is termed the "low mileage bias" [20-22]. Low mileage bias has implications for understanding the safety of older rural drivers because they may travel longer distances than older urban drivers and undertake more driving on high-speed rural freeways, which would be expected to reduce their crash rate per kilometre driven. However, when Hanson and Hildebrand [23] measured the exposure of older rural drivers to rural and urban roads, using both Global Positioning Systems (GPS) and self-report methods, they found that the proportion of travel on urban streets increased with self-reported mileage and decreased with age. This study also provided crash data, which indicated that rural drivers aged 81 and over had a higher crash rate per kilometre driven than their urban counterparts. They concluded that low mileage bias may not

exist for older drivers in the rural context. In their analyses, Hanson and Hildebrand did not examine the exposure of older rural drivers to potential conflict points (intersections) compared to older urban drivers. Such an examination could be important, given the reason proposed by Janke [21] for a reduction in crashes per distance driven for high mileage drivers was that they frequently use high-speed freeways with relatively few conflict points.

Other research has compared the rates of serious and fatal injuries in older drivers (≥ 75 years) and found that rural drivers are more than twice as likely to be seriously or fatally injured than urban drivers when involved in a crash [12]. Subsequent research by Thompson, Baldock, Mathias, and Wundersitz [24] established that certain environmental variables, which were more likely to be present in the crashes of older rural drivers, increased the chances that the driver would be seriously or fatally injured. The greatest risk of a serious or fatal injury to older drivers was having a crash on a road with a speed limit of 100 km/h or greater. That rural drivers were more likely to be involved in crashes on these high-speed roads probably reflects the greater exposure of this group to these roads. While Hanson and Hildebrand [23] examined the exposure of older rural drivers to high-speed roads in relation to the risk of crash involvement, they did not examine their exposure to these roads in terms of their increased risk of serious or fatal injury in the event of a crash. They also did not directly compare the exposure of older rural drivers to these roads with that of older urban drivers.

The aim of the present study was to examine whether older rural drivers are more restricted in their everyday driving mobility and whether they have a higher level of exposure to risk while driving, compared to older urban drivers. The driving exposure and travel patterns of both groups were monitored for a period of one week using GPS data loggers and travel diaries. The groups were compared in terms of the amount they drove over a one-week period, the activities they undertook through their driving, and their exposure to both intersections (potential conflict points) and high-speed driving conditions.

It was hypothesised that older rural drivers would drive longer distances than older urban drivers, but would be more restricted in their everyday driving mobility, making fewer trips and undertaking fewer discretionary activities. It was also hypothesised that older rural drivers would have a lower exposure to intersections (total intersections, intersections per distance, per time), but a higher exposure to high-speed driving environments, driving further and for longer periods on roads with speed limits of 100 km/h or higher, and at GPS-measured speeds of 100 km/h or faster.

Method

Participants

Participants were recruited from groups of older adults who attended road safety presentations given by the South Australian Royal Automobile Association, which is an

independent automobile club (of approximately 560,000 members). The presentations, entitled “Years Ahead”, were held at churches and senior citizens’ organisations in rural and urban areas of South Australia. One of the researchers (JPT) spoke at these presentations and invited attendees to participate in the research.

Participants had to be aged 75 years or older to be defined as an “older driver”. This age was chosen on the basis of a parallel study [12], which found that drivers of this age were significantly more likely to be seriously or fatally injured when involved in a crash than drivers below this age. They were also required to hold a driver’s licence for a car (class C licence, entitling a person to drive non-commercial motor vehicles not exceeding 4,500kg), to have driven at least once in the previous month, and speak fluent English.

The samples consisted of 28 participants from rural (10 females, 18 males) and 28 participants from urban (14 females, 14 males) areas of South Australia. Rural and urban participants were differentiated by a classification of South Australian residential postcodes, used by Kloeden [25], whereby urban areas (postcode 5000 to 5199) were defined as the capital city, Adelaide, and regions within a 5 to 20 kilometre radius. Rural areas (postcode 5200 to 5999) were defined as those regions outside of the urban area. A distance limit of within a two-hour drive from the city (a radius of approximately 100 km) was necessary, as the researcher was unable to routinely travel larger distances to recruit participants and collect data.

Participants ranged in age from 75 to 90. Rural participants had a mean age of 79.9 years ($SD = 3.8$) and urban participants 80.6 ($SD = 3.6$). According to licensing data from the South Australian Department of Planning, Transport and Infrastructure, 60,602 individuals aged 75 and over had a class C driver’s licence in South Australia in 2009. Eighty-three per cent were in the 75-84 age group and 17% in the 85 and over group, compared to 84% and 16% for the current sample. Therefore, the age composition of the sample closely approximated the broader population.

Materials

On-road driving was recorded using the 747ProS GPS Trip Recorder (hereafter referred to as Trip Recorder), manufactured by TranSystem Inc. (Hsinchu, Taiwan). For this study, it was set to record location and time data every second. Depending on the strength of the satellite reception (which can be affected by tall buildings, inclement weather, tunnels, etc.), the accuracy of the information that the Trip Recorder provides is within three metres for location and to the nearest second for time. This level of accuracy is consistent with other GPS data loggers [26]. It can be attached to the vehicle’s AC power and synchronised to operate with the vehicle’s ignition. Thus, it only records data when the ignition is on. This groups the data into separate ‘trips’ (i.e., a section of driving in which the vehicle was started, driven and then stopped at a destination) because it starts recording when the vehicle is started and driven, and stops when the vehicle is turned off.

A computer program was developed by the researchers to analyse the data from the Trip Recorder, which provided information on each separate trip: date and time; distance (kilometres) and duration (minutes); the average, minimum and maximum speeds (km/hour); and total kilometres and minutes over the combined trips. The program also allowed the user to view each trip on a map, which displayed the route taken and the travelling speed throughout the trip.

As the GPS could not record trip purpose or identify the driver, additional information was obtained through a telephone-based 'Travel Diary'. This involved the researcher telephoning the participant on a daily basis during the one-week data collection period to record the details of all of the driving that occurred in the vehicle(s) in which a Trip Recorder had been installed. Information was collected for each separate trip, including the date, the driver (for vehicles driven by more than one person, so that only data for the participating driver was analysed), start location, destination (where the trip ended), purpose (e.g., shopping), and the approximate start and end times.

Procedure

Data collection

A Trip Recorder was installed in each participant's vehicle. If they drove multiple vehicles, a Trip Recorder was placed in each. The researcher (JPT) telephoned participants daily to record the Travel Diary data, and returned at the completion of the seven day period to remove the Trip Recorder and record the final Travel Diary information. All data were collected between June 2011 and June 2012.

Data preparation

The GPS data for each participant were linked to the information from the Travel Diary in order to determine the driver and purpose of each trip. All trips made by non-participating drivers were excluded. Once a trip was linked to a specific purpose, it was classified as one of ten categories of activity in order to undertake a comparison between the rural and urban participants in terms of their access to specific categories of activities (an index of driver mobility). The ten categories were: 'leisure activities' (e.g., having a meal out), 'social activities' (e.g., visiting family/friends), 'community activities' (e.g., church), 'shopping', 'medical/health care activities' (e.g., doctor appointment or shopping at chemist, if the trip was for the driver and not for family or friends), 'other errands' (e.g., getting petrol), 'errands for other people' (e.g., transporting family/friends, including visits to the doctor), 'return home', 'move car' (i.e., a short distance), and 'unknown' (i.e., activity not identified). In addition, trips were grouped according to whether they were 'discretionary' (leisure, social and community activities) or 'non-discretionary' (shopping, medical/health care activities, other errands, errands for other people). Trips categorised as 'return home', 'move car' and 'unknown' were excluded from this latter classification.

Where two purposes were given for a trip (e.g., travel to a shopping centre for both shopping and lunch with friends), both were counted equally and treated as separate activities. Thus, the total number of activities over the week could be greater than the number of trips. In addition, where participants stopped at a destination for an activity, but did not turn their car off before proceeding to another destination, this would result in two activities for one trip.

Each trip that a participant made was viewed on the map program in order to count the number of intersections that they drove through. These intersections were those where the driver had to actively respond or attend to the driving environment. These included: signalised intersections, roundabouts, intersections where they turned from one road into another, intersections where they were required to give-way or stop, and railway crossings. Instances where they turned into a car park or driveway were not included. Information about an intersection (e.g. traffic lights, roundabouts) was provided on the map program, but some information (e.g. give-way/stop signs) could only be identified using 'Street View' in the Google Maps internet site (<http://maps.google.com/>), which provides a 360-degree street-level view of most roads. The total number of intersections for each participant was divided by both the total distance and total time they drove over the week in order to calculate the number of intersections they drove through per kilometre and minute driven.

Street View was used to identify the sections of a participant's trips that were on roads with a speed limit of 100 km/h or higher. The researcher would identify the driving route in the map display and examine the street-level images of the road in Street View to determine where speed limits started and ended, as indicated by street signage.

Data analysis

Independent samples *t*, Mann-Whitney *U* and chi-square tests were used for the comparisons between the rural and urban participants in terms of demographics, mobility and exposure variables. Two-tailed tests were conducted, using an alpha of .05. Cohen's *d* effect sizes were calculated to evaluate the magnitude of the group differences, with *d* = .2, .5 and .8 equating to small, medium and large effect sizes, respectively [27].

Results

Demographic comparison of rural and urban drivers

The rural and urban samples were firstly compared in order to determine whether they were demographically comparable. No significant differences were found between the groups in terms of their age, $t(54) = .73, p = .470$, years of schooling, $t(54) = 1.39, p = .170$, or gender composition, $\chi^2(1, N = 56) = 1.17, p = .280$, indicating that they were well-matched.

Table 1. Comparisons of distance driven, time spent driving and number of trips over one week of driving between rural and urban participants

	Rural Mean (SD)	Urban Mean (SD)	<i>t</i>	<i>p</i>	Cohen's <i>d</i> ^a
Distance driven (km)	165.6 (123.8)	94.8 (76.9)	2.57	.014*	.71
Time spent driving (mins)	233.7 (149.9)	209.0 (135.7)	.65	.521	-
Number of trips	23.7 (11.9)	20.8 (10.9)	.98	.334	-

^a Cohen's *d* effect sizes were only calculated for statistically significant differences.

* *p* < .05.

Driving mobility

The rural and urban participants were compared in terms of the distances driven, time spent driving and number of trips they made over the one-week period. In Table 1, it can be seen that the mean distance (kilometres) driven by rural participants was significantly higher than the mean for urban participants and that the difference between these means was medium-to-large in size. However, there were no significant differences between them in terms of the mean time (minutes) they spent driving or the mean number of trips they made. Thus, older rural drivers drove further

over the one-week period than older urban drivers, but spent a similar amount of time driving and made a similar number of trips.

The total activities of the rural and urban participants over the week, as well as the proportions that were grouped into each of the 10 categories of activity, are displayed in Table 2. A chi-square test revealed a significant association between rural/urban residence and activity-type, $\chi^2(9) = 34.41, p < .001$. However, the small Cramer's V statistic of .16 indicates that only 3% of the variation in activity-type was explained by whether the driver lived in a rural or urban area. Both groups undertook a similar number

Table 2. Activities of rural and urban participants by activity type, as well as discretionary/non-discretionary classification

	Rural % (<i>n</i> = 706)	Urban % (<i>n</i> = 632)
Leisure activities	6.9	4.4
Social activities	6.7	11.7
Community activities	9.5	8.9
Shopping	16.9	16.1
Medical/health care activities	3.5	5.9
Other errands	12.3	6.5
Errands for other people	5.0	6.0
Return home	30.5	32.0
Move car	2.1	3.6
Unknown	6.7	4.9
Total	100.0	100.0
	Rural % (<i>n</i> = 429)	Urban % (<i>n</i> = 376)
Discretionary ^a	38.0	42.0
Non-discretionary ^b	62.0	58.0
Total	100.0	100.0

^a“Discretionary” activities are not essential to everyday life but contribute to quality of life. This category includes leisure, social and community activities.

^b“Non-discretionary” activities are essential to everyday life. This category includes shopping, medical/health care activities, other errands and errands for other people.

Table 3. Comparisons between rural and urban participants in their exposure to intersections through one week of driving

	Rural Mean (SD)	Urban Mean (SD)	<i>t</i>	<i>p</i>	Cohen's <i>d</i> ^a
Total intersections	128.7 (83.8)	166.0 (113.3)	1.40	.168	-
Intersections per km driven	1.1 (0.8)	1.9 (0.5)	4.43	< .001*	1.21
Intersections per min driven	0.6 (0.2)	0.8 (0.2)	4.73	< .001*	1.27

^a Cohen's *d* effect sizes were only calculated for statistically significant differences.

* *p* < .05.

of activities in the categories of: community, shopping, errands for other people, return home, move car and unknown activities (see Table 2). Small differences were notable in leisure activities and other errands, with rural participants undertaking more activities of this type. There were also small differences in social and medical/health care activities, with rural participants undertaking fewer activities of this type.

The total number of activities (excluding returning home, moving car and unknown activities), as well as the proportions that were discretionary and non-discretionary, for rural and urban participants are also displayed in Table 2. The association between rural/urban residence and discretionary/non-discretionary activities was not significant, $\chi^2(1) = 1.36, p = .244$. Thus, the groups undertook a similar amount of discretionary and non-discretionary activities.

Exposure to risk

The groups were then compared in terms of the number of intersections they drove through. As seen in Table 3, the mean total number of intersections was lower for rural than urban participants, but this difference was not statistically significant. However, the means for rural participants in terms of intersections per kilometre and per minute driven were both significantly lower than those for urban participants and the differences between both sets of means were large in size. Thus, older rural drivers had a lower level of exposure to intersections (i.e. potential conflict points) on a per distance and time driven basis.

Next, the groups were compared in terms of the amount of driving done on roads with a speed limit of 100 km/h or higher. Table 4 shows that the mean distance travelled on such sections of road was higher for rural than urban participants. A non-parametric Mann-Whitney *U* test was used to test the significance of this difference because the

Table 4. Comparisons between rural and urban participants in their exposure to high-speed driving environments through one week of driving

	Rural	Urban	<i>U</i>	<i>p</i>	<i>z</i>
Distance (km) driven on roads with a speed limit of 100 km/h or higher					
Mean (SD)	79.8 (89.0)	3.5 (12.6)			
Median	64.9	0.0	614.00	< .001*	4.08
Time (mins) spent driving on roads with a speed limit of 100 km/h or higher					
Mean (SD)	54.7 (61.2)	2.4 (8.4)			
Median	43.9	0.0	614.00	< .001*	4.08
Distance (km) driven at speeds of 100 km/h or faster					
Mean (SD)	21.0 (40.3)	1.0 (5.2)			
Median	1.6	0.0	614.00	< .001*	4.18
Time (mins) spent driving at speeds of 100 km/h or faster					
Mean (SD)	11.9 (22.6)	0.6 (3.0)			
Median	0.9	0.0	614.00	< .001*	4.18

* *p* < .05.

data were non-normally distributed and included numerous zero values (e.g., 82% of urban participants did not travel on roads with these speed limits during the study period). This test indicated that the median distance driven on these sections of road by rural participants was significantly higher than that of the urban participants (see Table 4). In terms of time spent driving on such sections of road, the mean for rural participants was higher than that of the urban participants. Again, a Mann-Whitney *U* test revealed that rural participants had a significantly higher median time than urban participants.

Finally, the rural and urban drivers were compared in terms of the distance and time that they drove at speeds of 100 km/h or faster. Table 4 shows that the mean and median distance for rural participants was higher than for the urban participants, which was supported by a significant Mann-Whitney *U* test. The mean and median time that rural participants drove at speeds of 100 km/h or faster was also statistically significantly higher than for the urban participants.

Discussion

This study was designed to determine whether older rural drivers are more restricted in their everyday driving mobility, and whether they have a higher level of exposure to risk while driving, than older urban drivers. To this end, the driving exposure and travel patterns of older drivers (aged ≥ 75) from rural and urban areas of South Australia were monitored for one week using GPS data loggers and telephone-based Travel Diaries. Consistent with our predictions, older rural drivers drove further than their urban counterparts in terms of the total distance travelled per week. It was also expected that, as a result of the distances they have to travel, older rural drivers would make fewer trips than older urban drivers. However, the number of trips did not differ, suggesting that older rural drivers are not restricted in their driving mobility.

It was also thought that older rural drivers might prioritise their driving and neglect certain discretionary activities (e.g., social activities). While they did differ from older urban drivers in the extent to which they undertook certain types of activities, these differences were small. Furthermore, they did not differ in the number of activities that were deemed to be discretionary or non-discretionary, further suggesting that older rural drivers are not restricted in their driving mobility. This is a positive finding, given the abundance of research that highlights how important driving mobility is to the health and well-being of older adults [1, 2, 5-7].

Interestingly, despite travelling greater distances than their urban counterparts, rural drivers did not differ in the amount of time that they spent driving. This may be explained by the finding that they undertook a larger amount of driving at high speeds than urban drivers and so covered greater distances in the same amount of time. It may also be explained by there being fewer intersections on rural roads and less traffic congestion, which would reduce their travel times.

While it was predicted that the exposure of older rural drivers to intersections would be lower than that of older urban drivers, the two groups drove through a similar total number of intersections. However, this was likely to be due to the greater distances the rural participants drove over the week. Indeed, they were exposed to fewer intersections on a per kilometre driven basis. Older rural drivers were also found to travel through fewer intersections per minute driven. The findings support Janke's [21] suggestion that higher mileage drivers who travel on high-speed freeways encounter fewer intersections. Older rural drivers are exposed to less risk in terms of potential conflict points per distance and time driven than older urban drivers because of the roads they travel on. It would be expected, therefore, that this would reduce their per distance driven crash rate. However, Hanson and Hildebrand [23] found that rural drivers aged 81 and over had a higher crash rate per kilometre driven than their urban counterparts. While it may be the case that older rural drivers, despite their lower exposure to intersections per distance and time driven, are involved in more crashes than older urban drivers, other research by Thompson et al. [12] has shown that they are involved in fewer total crashes, as well as crashes per head of population and per licensed driver. Consequently, further research in this area may be required.

The exposure of older rural drivers to high-speed driving environments was clearly greater than that for older urban drivers. Older rural drivers travelled for longer distances and for longer time periods than older urban drivers on roads with a speed limit of 100 km/h or higher and at GPS-measured speeds of 100 km/h or faster. Previous research has suggested that high-speed roads [24] and high-speed travel [28-30] increase the likelihood of serious and fatal injury in a crash situation and this is likely to be exacerbated for older persons, given their frailty and susceptibility to increased injury severity [13, 14].

Future research should attempt to identify ways to reduce this exposure for older rural drivers, possibly through drivers avoiding areas with speed limits of 100 km/h or higher as much as possible. However, for many, this may not be possible, as it may be the only way they can reach their destinations. A second option would be to reduce the speed limit in these areas, in particular from 110 to 100 km/h. Long, Kloeden, Hutchinson, and McLean [31] have previously shown that a reduction in the 110 km/h speed limit to 100 km/h on specific rural roads in South Australia reduced both the average travelling speed and the number of crashes in which there were casualties at these sites. Reductions in speed limits are likely to benefit the safety of drivers of all ages. A third option would be to encourage older rural drivers to purchase the newest vehicles they can afford when they are in the market, as newer vehicles provide superior protection from serious or fatal injury in the event of a crash [32-34]. A fourth option would be to increase public transportation services (e.g. buses) or subsidise private services (e.g. taxis) in rural areas, where the availability of these alternative options is often limited [35], and encourage older adults to increase their usage of these services. However, the cost of increasing

these services may be prohibitive in small communities and remote areas. Alternatively, rural councils, as well as churches and senior citizens clubs, could be encouraged to increase their provision of community-run transportation services (e.g. community buses or volunteer driver systems).

Study limitations and future directions

There are a number of limitations that should be acknowledged. Firstly, the rural participants were recruited from areas relatively close to the capital city (i.e., within approximately two hours driving distance), which meant that older drivers from remote rural locations were not included. The proximity of the rural participants to the capital city, as well as the fact that many lived in retirement villages, large towns and regional centres, may mean that they had access to necessary services and encountered traffic conditions not too dissimilar to the fringe areas of Adelaide. Thus, it is likely that they had better access to services and more opportunities to socialise than individuals from remote locations. People residing in remote areas are likely to drive further to reach their destinations and, consequently, may have an even higher level of exposure to high-speed roads. It is also likely that their mobility may be more restricted if they have to drive further distances. Therefore, the differences between the rural and urban participants (number of trips and activities) may have been larger if remote drivers were included. Older drivers from remote areas should be recruited, if possible, in any future research on this topic.

Another limitation was that participants were recruited from senior citizens clubs and churches. These attendees, particularly those willing to volunteer for the study, may be healthier and more active than other adults of their same age. Indeed, that they were able to travel from their homes to these organisations suggests they are mobile. Consequently, these rural participants may not have been deterred by driving longer distances, which may explain why they were not restricted in their number of trips or activities. Future research should assess the health of the sample, and endeavour to include participants who vary in their health and mobility. It should also be acknowledged that participants who are concerned enough about their driving, and road safety in general, to attend a driving safety presentation may not be representative of all older drivers. Indeed, it might have been anticipated that they would attempt to reduce their travelling speed while they were being monitored by the GPS logger. However, any such adjustments would have been equivalent across the rural and urban groups and the difference between them in terms of the amount they drove at GPS-measured speeds of 100 km/h or faster was large. Therefore, it is unlikely that such sample bias had any considerable effects on the overall outcomes of the study.

It is also possible that the participants altered the amount that they drove, their speed and/or their activities because their driving was being monitored. In particular, the placement of the Trip Recorder on the dashboards of their vehicles may have acted as a visible reminder of the study.

However, initial pilot testing of the devices used in the present study found that the participants reported that the devices were barely noticeable and did not affect their driving behaviour [36]. Research by Blanchard, Myers, and Porter [37], which also used GPS devices to monitor the driving of older adults, produced similar findings.

In addition, it was only possible to monitor one week of driving for each participant. Although data based on uncharacteristic weeks (e.g., where they went on a driving holiday or became unwell) were excluded, it is still possible that the week may have been atypical. Future research could monitor driving for a longer period to address this issue. This would, however, increase the already large amount of data provided by the GPS loggers, as well as the time required to analyse it. For present purposes, it was thought that an atypical week was equally likely to occur in either group, in which case any effects on the measurements of routine driving exposure and travel patterns are likely to be evenly distributed across groups.

It should also be noted that the data were collected over a 12-month period and so there may have been seasonal effects on travel behaviour. However, the rural and urban data were collected concurrently and, therefore, any such seasonal effects are also likely to be equal across groups.

Conclusion

Recent research by Marottoli and Coughlin [16] highlighted the importance of balancing the safety of older drivers while they are on the road with the competing need to maintain their mobility for as long as possible in order to optimise their quality of life. The present research indicates that this balance is particularly important for older drivers who live in rural areas. A greater proportion of their travel is undertaken on high-speed roads than is the case for older urban drivers, which increases their risk of serious or fatal injury in the event of a crash. Possible ways to deal with this increased risk include reducing speed limits in rural areas (e.g., 110 to 100 km/h) and encouraging older rural drivers to drive newer and safer vehicles, which should lower the risk of injury without affecting mobility.

Acknowledgements

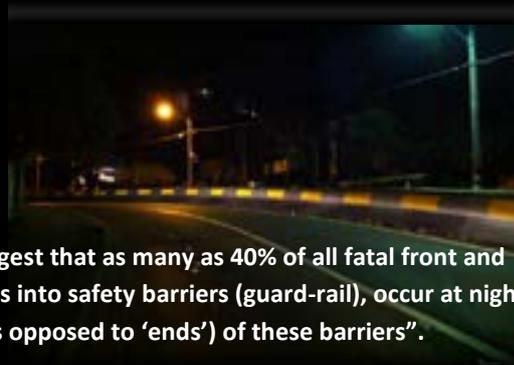
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